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**Creators:** Faber, William M.

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# THE LOW LAKE LEVELS

BY WILLIAM M. FABER III

**T**HERE is perhaps no problem of more general interest to the millions who make their homes on the shores of the Great Lakes, than that of the rapidly receding water levels. Few people realize what the real problem of the lake levels is. They have a vague idea that Chicago is taking some water, but how much or for what purpose they do not know. Nor do they realize that our steel industry and many others are entirely dependent upon the Great Lakes for the transportation of basic raw materials. The low levels are causing decreased tonnage, resulting in increased freight rates which of course are finally paid by the consumer. Not only the utilitarian but also the scenic value of the Great Lakes is impaired by the low levels which has destroyed the beauty of more than one beach and summer resort. Then again the St. Lawrence Waterway project cannot be approved as long as the water levels are fluctuating, for it might be rendered useless by this condition.

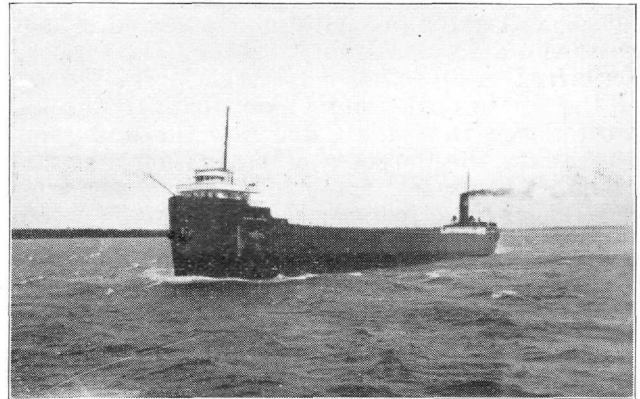
This article will deal in turn with the causes, effects, and suggested remedies for the low levels, in an attempt to give briefly a general view of the situation.

Secretary of Commerce, Herbert C. Hoover, has said that the Great Lakes are the greatest transportation system in the world. Some idea of this greatness may be gathered from the following comparisons. In any ordinary year the tonnage of freight carried on the lakes exceeds 90,000,000, which equals the total foreign commerce of the Atlantic, Gulf and Pacific ports and is greater than the total tonnage volume of the 297 navigable rivers of the interior. The traffic through the Soo Canal alone exceeds the total through the Panama, Suez, Manchester, and Kiel ship canals. \$100,000,000 per year is actually saved in reduced freight rates and \$15,000,000 more could be saved if the lakes were kept at their normal levels.

Tributary to the Great Lakes is the world's greatest economic region. On the west is America's granary; on the north, undeveloped mineral and lumber resources; on its shores the great cities with their manufacturies, the enormous ore deposits, coal beds, and transportation systems; and on the east, the Atlantic Ocean, a highway which provides an outlet for Middle Western products to the far corners of the earth. This region with 35,000,000 population has 11% of the total area of North America and one-fourth of its population.

## Comparison of Levels.

"The levels of the lakes have been recorded monthly by the U. S. Lake Survey since 1860; and at varying periods before that since 1838, when



The Samuel Mather, a typical 1,600-footer

the first true determinations of elevation were made. From these records an accurate comparison of past and present levels can be made.

There are certain periodic variations of levels which are entirely independent of each other and of the long periods of fluctuation, or real variation of levels. They are of three types.

### 1. Seiches, or wind variation.

(A heavy east wind will pile up the water at the western end of Lake Erie until it is often seven feet higher than at the eastern end.)

### 2. Daily variations (of small consequence) due to the tidal action of the sun and moon.

3. Annual variations, due to ice retardation and seasonal difference of precipitation. The highest elevations are recorded in July and August and the lowest in January and February. The average annual change is about one foot, though ice retardation of the outlet may increase this.

It is the real variation of levels that is of interest rather than these periodic fluctuations. Hereafter all levels mentioned are to be taken as mean annual levels unless otherwise noted. The standard for lake levels is generally set as the mean for 1883-87. Upon these levels are based all plans for future regulation.

The present trend of rapidly decreasing levels began in 1918, and is still continuing. From 1918-1925, Lake Huron—Michigan, fell three feet. A two-foot decrease was noted during the last five years.

The other lakes have fallen proportionately with the exception of Lake Superior, which has been kept at a fairly constant level by regulating works located at its outlet.

In the following table, compiled from figures of the U. S. Lake Survey, are given the figures from 1838 to 1925.

Lake	Highest Recorded Levels 1838	Standard Levels 1883-87	Busiest Season on Lakes, 1916	Lowering 1920	Levels 1925
Superior	605.32	602.00	603.00	602.20	601.10
Huron	584.69	582.80	580.22	580.30	578.10
Michigan	584.69	582.80	580.22	580.30	578.10
Erie	575.11	573.12	571.31	571.12	570.90
Ontario	248.98	247.05	246.43	245.40	244.90

Note 1: In the year of 1923, there was less tonnage carried than in 1916 because of lower levels, although there were plenty of cargoes and more boats were in operation.

### **The Principal Causes of Low Levels.**

The low lake levels are due to artificial causes as diversion and deepening of channels; and natural causes as lack of precipitation, increased evaporation and deforestation.

Chicago is diverting a river one-third the size of the Mississippi from Lake Michigan through the Chicago Drainage Canal into the Mississippi system for the purposes of navigation and sanitation. The present rate of flow is between 9,000 and 10,000 cubic feet per second. This is accomplished by reversing the flow of the South Branch of the Chicago River and cutting a canal through the watershed to the Des Plaines River, a part of the Mississippi system. When this canal was built in 1900, a real need existed, for the art of sewage disposal was yet in its infancy; but, now it is a question of whether such diversion is justifiable. During the last five years, Lake Huron-Michigan was lowered six inches from this cause.

The diversion around Niagara Falls totals 56,000 cubic feet per second, most of which is used for power purposes. This has little effect on lake levels with the exception of the following canals which take their water directly from Lake Erie: The Chippewa power canal of the Hydro Electric Commission of Ontario, the Welland, Black Rock, and New York State Barge Canals. The total effect is a lowering of four inches on Lake Erie and two and one-half inches on Lake Huron-Michigan.

The second cause is the deeper channels of the connecting rivers. A few centuries ago, the early French explorers reported channels of eight to twelve feet in these rivers. These remained unchanged till around 1880 when they were first deepened for navigation purposes. The depth is now twenty-one feet and the flow through these outlets is nearly doubled. The result is a lowering of Lake Huron-Michigan two and one-half inches.

To prevent the lowering of Lake Superior from such causes, regulating works were built at the Soo in the form of a dam which raised the level of Lake Superior one foot and subsequently lowered the other lakes three inches.

The first two causes account for fourteen inches decrease in Lake Huron-Michigan, out of a total of twenty-six inches for the last five years. The remaining twelve inches are chargeable to the natural causes. Lack of precipitation and the resultant evaporation due to a great increase in sunlight, are partly responsible for these twelve inches. During the period from 1919 to 1923, the precipitation on the Lake Superior basin was only 64% normal. From personal observation, it was noted that during the summer of 1923, there were only two rainy days in two and one-half months on the Great Lakes.

The fact that the virgin forests which covered the states of Michigan, Wisconsin and Minnesota three decades ago have been cut down may also be responsible in part for this lack of precipitation.

### **The Effects of Low Levels.**

The low levels have affected every phase of economic and social life upon the lake borders today;

included among which are navigation, power, business and scenery.

The effect on navigation reaches the whole length of this 2200 mile highway, rendering navigation only 75% efficient. Very recently two ocean liners were grounded below Montreal because of insufficient water from this cause.

The lakes bulk freighter of six hundred foot length is built to carry a maximum cargo on a twenty-one foot draft. Any lessening of this draft brings a decrease of cargo capacity at the rate of one hundred tons per inch. The recommended drafts for 1920 and 1925 were twenty feet, six inches and eighteen feet, nine inches, respectively, which showed a loss of twenty-one inches in draft or 2100 tons cargo capacity per trip which at the average freight rate of \$.40 per ton means a loss of \$840.00 for each trip or \$9,000,000 a year.

There is close to a billion dollars invested in boats, docks and handling machinery along the lakes and any heavy decrease in the gross receipts causes a heavier decrease in profits which makes it imperative to the Lake Carriers, that some action be taken immediately to restore the levels to normal.

The effect on power has been such that any new developments projected have been held up till the levels become stabilized. Every six inches that the lakes are raised will develop 300,000 horsepower at Niagara and 100,000 horsepower on the International section of the St. Lawrence River.

The scenery of every important resort on the lakes has been greatly impaired by low levels. During the summer of 1925, muddy ditches were seen in place of the canals that once honeycombed Detroit's beautiful island park, Belle Isle. Lack of water has even been felt at Niagara Falls. This past winter the flow of the American Falls was entirely shut off for a few days, a condition unprecedented in the history of the Falls.

Business as a whole is affected by low levels. The basic manufacturing industry, steel, is dependent entirely on the Great Lakes for transportation of its principal raw material, iron ore. Here is a cheap system of transportation which keeps production costs low, and therefore allows a reduction in price of the finished product. This system is rendered less efficient by low levels. The price of steel is forced up; there are fewer orders; a gradual lower trend is observed in the stock market and an upward trend is noted in the price of products based on this commodity.

New business cannot be attracted to the cities along the lakes till the levels are restored, for advantageous lake transportation lies in its cheapness which cannot be maintained if the levels recede much below the present stage.

### **The Remedies of Low Levels.**

While the present levels are low there is nothing to indicate that this condition is permanent. Properly applied remedies will prevent any repetition of low water stages.

The remedies to be described are of two types, direct and indirect; of which the direct seems to be of the greater value. The direct remedies may be applied by:

1. Deepening the connecting channels, and harbors.

2. By raising the surface levels of the lakes by compensating or regulating works.

To efficiently restore the levels at a minimum cost a combination of both methods will have to be used.

Compensating works are, as the name implies, works built to compensate for the low levels. These consist of submerged weirs, placed at the lake outlets. This type of works has no regulating effect for it raises, not only the low stages, but also the high stages, and does not prevent fluctuation.

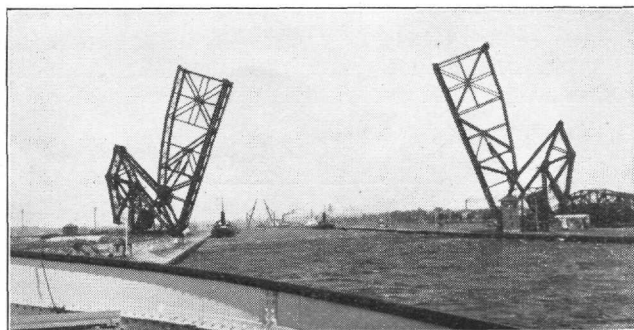
However, regulating works to consist of dams, expansion basins and sluice gates can be built at the lake outlets to provide an absolute control. In times of scarcity they will permit the release of water stored in times of plenty.

These works with the deepening of the connecting river channels present the most satisfactory solution of the lake levels problem. These works to be entirely successful must be built at each lake outlet, because of the great length of time necessary for the released water of one lake to fill up the next lower lake. Two years are required to raise one lake a foot by lowering another one the same amount. For instance, if it were decided necessary to increase the flow of the St. Lawrence River by 20,000 cubic feet per second the sluice gates at the lower end of Lake Ontario would be opened to permit that increased flow. Simultaneously the gates at the lower ends of Lakes Erie, Huron and Superior would be opened to allow the same release. In the end only Lake Superior would be lowered which, because of its great area and depth can best stand the additional diversion of its waters.

The elapsed time that will be required to restore the levels is unknown though the levels may possibly be raised four or five feet in eight years if the flow of the St. Lawrence were cut 20% and in twenty months if entirely shut off. Special care must be taken in the building of the regulating works that they do not raise the water to destructively high levels.

Following is a table showing a comparison of proposed maximum and minimum levels with the present low levels.

Lake	Highest Levels Recorded 1888	Proposed Maximum Levels	Margin of Safety	Proposed Minimum Levels	Storage Range	Present Minimum Levels	Gain in Levels
Superior							
Huron	605.32	604.5	.8	602.0	2.5	601.0	1.0
Michigan	584.69	583.5	1.2	581.0	2.5	578.6	2.4
Erie	575.11	574.5	.6	573.0	1.5	570.9	2.1
Ontario	248.98	248.5	.5	246.0	2.5	244.9	1.1



Double Jack-Knife Bascule Bridge over Saulte Ste. Marie Ship Canal

Note 1. The proposed mean levels would equal the mean levels of 1883-87.

2. The margin of safety is the difference between the highest levels ever recorded and the maximum levels to be allowed by regulation.

3. The storage range is the difference between the proposed maximum and minimum levels. It is this water which acts to regulate the levels in times of scarcity.

4. The gain is the difference between the proposed minimum and the present minimum.

A remedy for the situation that has been proposed within the last few months is a new great lake to the north of Lake Superior. Mr. Lorne Campbell, an engineer of Toronto, has spent a considerable portion of the last five years exploring the nine hundred miles of waterways in this region and has evolved a plan which he claims is entirely practical from both engineering and economic standpoints.

The watershed dividing the waters of the St. Lawrence system and those flowing into Hudson River is only one hundred miles north of Lake Superior. He proposes to dam the Albany River and its principal tributary, the Ogoki to the north of the watershed which flows northeast into James Bay; then cut through the divide and allow the waters from the large reservoir to flow south through Lake and River Nipigon into Lake Superior.

The Albany River is called the St. Lawrence of the north because of its immense size and scenic grandeur, but economically, all its water is going to waste for it is only used as a means of transportation between trading posts by trappers and Indians. However, if it were put to the use suggested it would add 20,000 cubic feet per second to the Great Lakes and 600,000 additional horsepower at Niagara Falls.

From a comprehensive study of the region, Mr. Campbell has become convinced that there will be no unusual engineering difficulties encountered in carrying on his project. The divide is so low at the point he proposes to build a canal that a rock cut one mile in length will be sufficient.

He also believes that a large portion of the cost of construction of the dams and canal can be paid from the profits of clearing the virgin forest from the 14,000 square miles to be covered by this lake. The clearing of the forest and construction of the

lake will provide employment for twenty thousand men for seven years. Not only will the largest mills in the world be required to care for the lumber output, but the untapped riches of the earth will become accessible to through transportation. The total cost of this project is estimated at \$175,000,000 or about one-third of the cost of the Panama Canal.

An indirect remedy which may prove of great value in the more distant future is the probable reforestation of Michigan, Wisconsin and Minnesota, and the subsequent increase in precipitation.

#### The Case of Chicago.

Chicago, to which is chargeable one-fourth of the loss in levels, has at great expense collected

data to support its claims to its legal and moral right to divert 10,000 cubic feet per second from Lake Michigan through the Chicago Drainage Canal into the Mississippi system. Lined up on her side is the State of Illinois and every Mississippi River State which are receiving benefit from the increased flow in the Mississippi River. Arrayed against her are the Lake States and cities and a united Canada.

Chicago's claims come under the heads of sanitation and navigation. Her chief contention is that she is legally entitled to divert 10,000 cubic feet per second from Lake Michigan because the boundary treaty of 1910 allowed Canada 16,000 cubic feet per second more at Niagara Falls than the United States to compensate for this same diversion.

To support her moral right to divert water from one system to another, Chicago comes forward with the statement that Lake Michigan is entirely within the United States.

Chicago cites that wonders have been accomplished for sanitation by her Drainage Canal.

1. It has cut the typhoid death rate from 174 per 100,000 to 1.1 per 100,000.
2. It has allowed her to build and keep clean some of the finest bathing beaches in the world.

In the interests of her navigation project which at present occupies the stage. The Great Lakes to Gulf waterway, Chicago maintains that it is necessary to divert ten thousand cubic feet per second to keep up a nine-foot stage from Chicago to St. Louis. This project has become Chicago's principal weapon in her fight to take water since she was ordered by the Secretary of War to cut down her diversion for sanitary purposes to 4,167 cubic feet per second by 1929.

#### **The Lake Carriers Case.**

The shippers and people of the Lake States as represented by the Lake Carriers Association and various state governments are solidly against any increase in the present Chicago diversion. At present some of the greatest corporation lawyers in the country are being retained to prevent Chicago from securing any increased diversion by law.

The arguments of this side are based on the enormous damage to navigation due to Chicago's diversion.

This side contends that Chicago has no legal or moral right to divert water from the Great Lakes to the Mississippi River. In the first place, Chicago has never received the sanction of the United States government for its canal. It was built solely on the authority of the State of Illinois. The latest order of the Secretary of War definitely limits the diversion through the Chicago Drainage Canal to 4,167 cubic feet per second by 1929. During the intervening period of temporary necessity, until Chicago shall have had time to complete sewage disposal plants for a population of 1,200,000 people, 8,500 cubic feet per second diversion will be allowed.

Henry L. Stimson, former Secretary of War, said, in deciding the Chicago Diversion Case, in 1913:

"I do not for one moment minimize the importance of preserving the health of the great city of

Chicago; but when a method of doing this is proposed which will materially injure a most important class of the commerce of the nation and which will also seriously affect the interests of a foreign power, it should not be done without the deliberate consideration and authority of the representative of the whole nation." (')

The statement of Francis King, attorney of Kingston, Ontario, that Canada will not spend one cent for the St. Lawrence Waterway Project until the Chicago question has been settled, is a recognition of the fact that it is useless to even consider this project until the levels are permanently adjusted. It will take at least ten years to adjust the levels and forty years after that to complete the St. Lawrence Waterway. The sooner the people come to realize these facts, the sooner will their visions of a great economic empire come true.

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